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FINAL REPORT

FNAS SHORT TERM PREDICTIONS OF SOLAR ACTIVITY
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As stated in our proposal, during the course of our work we started a systematic study of source processes on the Sun and energy conversion processes in the solar atmosphere, with the objective of improving our physical understanding of solar active phenomena and, thus, our prediction capabilities.

We also noted that most studies to date have tried to address the issue of short–term predictions in a forward manner, i.e. looking at the development of ambient conditions that led to active events. In our approach, as we shall se below, we took the opposite path, looking at repetitive patterns of activity (flare homology) and their changes, trying to associate these with changing ambient conditions. To do this, we used observations from the Solar Maximum Mission spacecraft and magnetic field data from the Marshall Space Flight Center. As we shall also see, our results are rather preliminary, due to the limited amount of time and resources devoted to this research, but at the same time reveal some very interesting potential.

1. Flare homology studies.

As planned, we studied two sets of observations of repetitive flaring patterns seen in active regions of April and November 1980, for which we had excellent SMM and MSFC coverage. The general characteristics of major flares in these regions were discussed by Machado et al. (1988), and now we extended the study to all events observed over long observational sequences ranging from 12 hrs to several days. In these, we found minor events 100 to 1000 times weaker than flares (the X–ray microflares), which show some interesting and unexpected properties. First, in terms of their spatial characteristics microflares and flares are homologous, indicating that they occur within the same magnetic configuration. Second, flares and microflares mix randomly, i.e. there is no microflaring pattern followed by flaring pattern or viceversa, they are clearly intermingled. Third, microflares show distinct properties in X–ray emission and thermodynamic parameters, that clearly distinguish them from flares, contrary to the conventional wisdom that says that a major flare can be a conglomerate of 1000 or more microflares.

These results suggest that flares and microflares have different energy release drivers and/or processes, in spite of their similarities, like e.g. Sweet–Parker for microflares versus Petschek–type reconnection for flares. This new result then shows a need for further studies, observational and theoretical, to ascertain conditions under which different activity

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levels may occur.

2. Magnetic field topology.

In terms of our study of ambient conditions, we started a collaboration with Dr. J.–C. Henoux of Meudon Observatory, on the topological characteristics of the magnetic field in flaring regions. We have developed a computer code that allows us to calculate field line connections based on data such as those from MSFC, compute an equivalent configuration based on magnetic dipoles and, from these, obtain neutral lines that match the observations and locate the separator in complex field configurations. The separator is, in three dimensions, the generalization of the classic X–type neutral point where current sheets can form. Machado et al. (1983, 1988), Henoux and Somov (1987) and Gaizauskas (1990), have shown its importance as a possible point of trigger for energy release. When our work (which will continue under an NSF funded cooperative program between UAH and Meudon) is completed, we shall apply our method to a variety of well observed cases.

3. Publications.

The results of our microflare/flare studies were presented at the FLARES 22 Workshop on the Dynamics of Solar Flares, held in Chantilly, France. An extended summary will be published in its proceedings and a full–length paper is in preparation.

REFERENCES

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